

CONTRACT NO. DABT60-90-D-0010
DELIVERY ORDER 0012

FINAL TECHNICAL REPORT

(CDRL A007)

**DEPOT MAINTENANCE PLANT EQUIPMENT (DMPE)
MANPRINT ANALYSIS PROJECT**

15 February 1995



Submitted to:

**U.S. Army Training and Doctrine Command (TRADOC)
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FINAL TECHNICAL REPORT

Depot Maintenance Plant Equipment (DMPE) MANPRINT Analysis Project

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FINAL TECHNICAL REPORT

Depot Maintenance Plant Equipment (DMPE) MANPRINT Analysis Project

SECTION 1.0 INTRODUCTION

1.1 BACKGROUND

Based on guidance and direction contained in the National Defense Authorization Act for Fiscal Years 92 and 93 and ever decreasing defense budget expenditures, it has been determined that the Army would best be served by establishing its own industrial base to support its aviation depot maintenance activities relative to the first-line "Force Modernization" category aircraft systems, which will be centered at Corpus Christi, TX. This enhanced capability will provide a more cost effective means of support and reduce time delays in acquiring newly overhauled/repared components and parts, thereby increasing the availability of aviation assets to Army units.

Existing depot maintenance support facilities for Army aviation in Corpus Christi, TX, only have adequate capabilities for rework and depot maintenance support for older less sophisticated airframes such as the UH-1H, AG-1G and S, CH-47B and C, and OH-58A, B and C models of aircraft.

The modernization of Army aviation has necessitated the update of these facilities to keep pace with current and future support requirements dictated by the fielding of the AH-64A Apache and its follow-on improved models, OH-58D Kiowa Warrior, improved UH-60 Blackhawk models, and the CH-47D Chinook. Some of these airframes have been fielded for several years; however, it is only now that requirements are being shifted to ensure establishment of the latest "state-of-the-art" organic facilities and in recognition of declining contractor production line support. Should continued support be sought from materiel prime contractors, the unit price will increase to prohibitive levels due to the limited size of procurements. In-house support will prove more cost effective, reduce time delays acquiring reworked components, and increase overall aircraft availability.

The activities supporting these MANPRINT analyses have been accomplished at sites other than Corpus Christi. Much of this MANPRINT analysis has involved reviews and update of Statements of Work (SOWs) and DMPE Procurement Data Packages (PWDs) to ensure incorporation of MANPRINT concerns during the acquisition of new equipment to ensure the smoothest possible implementation and operations of this equipment by government personnel.

A-1

1.2 PURPOSE AND OBJECTIVE

The purpose and objectives of this delivery order were to address MANPRINT considerations in the preparation of SOWs, procurement packages, and government solicitations regarding the acquisition of various new equipment for the U.S. Army's Corpus Christi aviation maintenance depot. Benefits of the overall acquisition effort will provide the government with its own in-house upgraded industrial/maintenance production capability which will provide more cost effective maintenance support, reduce maintenance part time delays, and increase overall availability of Army aviation assets.

Specific benefits of this effort have influenced the overall acquisition processes by ensuring MANPRINT considerations are properly and adequately addressed in solicitations. This has resulted in reducing the net strain on the Army, specifically the Army Materiel Command (AMC) and their subordinate organizations (ATCOM/DESCOM) in the areas of materiel support and depot staffing, and TRADOC schools, with regard to increased Manpower, Personnel and Training (MPT) requirements, as well as ensuring human factors engineering (HFE), system safety, and health hazard concerns are mitigated.

Figure 1-1 provides an overview of the schedule and milestones of this analysis effort. **Figure 1-2** provides a breakdown of the labor and travel costs associated with the accomplishment of this analysis.

Specific areas reviewed during the analysis included:

- a. Gauging the potential MANPRINT impacts on depot operations with regards to newly acquired equipment which results in increased capabilities and requirements.
- b. Manpower: How much will manpower requirements increase at Corpus Christi to support the expanded role of the facility.
- c. Personnel: With the acquisition of this new support equipment and capabilities, what changes in the skills, knowledge, and abilities (SKAs) will occur for government personnel, and how will these new SKA requirements be fulfilled.
- d. Training: What training requirement increases will result from the acquisition of this new equipment?
- e. Human Factor Engineering (HFE): Are appropriate ergonomic, anthropometric, and other HFE concerns and considerations addressed in solicitations to ensure the equipment will meet government and industry specifications and standards.
- f. Health Hazards: Are appropriate health hazard specifications and standards for government and industry adequately addressed in solicitation requirements to ensure new equipment will be safe to operate and maintain.

**CONTRACT NO. DABT60-90-D-0010, DELIVERY ORDER 0012
DEPOT MAINTENANCE PLANT EQUIPMENT (DMPE)
MANPRINT ANALYSIS**

EVENT	5/93	6/93	7/93	8/93	9/93	10/93	11/93	12/93	1/94	2/94	3/94	4/94	5/94	6/94	7/94	8/94	9/94	10/94	11/94	12/94	1/94
	3rd Qtr FY 93		4th Qtr FY 93		1st Qtr FY 94		2nd Qtr FY 94		3rd Qtr FY 94		4th Qtr FY 94		1st Qtr FY 95								
DELIVERY ORDER PERIOD OF PERFORMANCE																					
A. Outline Management Plan	▲																				
B. Delivery Order Initiation Meeting	▲																				
C. Detailed Management Plan	▲																				
D. Monthly Progress Report	▲																				
E. Reference Data Collection	▲																				
F. SME Interviews	▲																				
G. Ad Hoc Technical Reports	▲																				
H. In-Process Review (IPR) A																					
I. Cross Correlation and Analysis of Data																					
J. In-Process Review (IPR) B																					
K. Draft Technical Report Development																					
L. Final Technical Report Development																					
M. Minutes	▲																				
N. Handouts	▲																				

△ SCHEDULED DATES
▲ ACTUAL DATES

Figure 1 - 1

Personnel and Travel Cost Summary

Category	Rate	Hours	Total
Analysis Manager	\$27.36	568	\$15,540.48
Force Structure Analyst	\$70.82	2544	180,166.08
Manpower Analyst	\$20.48	2578	52,797.44
Senior Training Analyst	\$18.37	1690	31,045.30
Decision Analyst	\$20.40	760	15,504.00
Admin. Support	\$24.53	634	15,552.02
Direct Total Labor		8774	<u>\$310,605.32</u>
Travel (Loaded)			<u>27,090.72</u>
ODCs (Loaded)			<u>4,320.00</u>
Total Firm Fixed Price Amount			<u>\$342,016.04</u>

Detailed Breakdown of Personnel and Travel
Costs Available in Delivery Order 0012

Figure 1 - 2

1.3 SCOPE

The MANPRINT analysis products developed through this analysis support ongoing government efforts in the acquisition of DMPE that have been used for initial establishment, upgrade, and sustainment of an enhanced industrial/maintenance/production capability at the U.S. Army Aviation overhaul facility at Corpus Christi, TX.

SECTION 2.0

PROGRAM DESCRIPTION

2.1 DMPE ACQUISITION PROGRAM

The DMPE acquisition program is primarily an effort involving the procurement and various industrial grade maintenance systems for both electrical and mechanical systems. For the most part, these systems are Commercial Off-the-Shelf (COTS) items and once installed equate to a turnkey system. These maintenance systems provide the facilities at Corpus Christi Army Depot (CCAD) with greatly enhanced capabilities. With these new systems, however, come increased manpower and personnel requirements for operations, maintenance and support. These increased requirements correspond to heightened workloads at CCAD due to the shift from Contractor Logistics Support (CLS) for "Force Modernization" category aircraft systems to organic in-house "state-of-the-art" facilities and capabilities.

2.2 AFFECTED AIRCRAFT SYSTEMS

The following listings provide an overview of the equipments being procured for the DMPE program at CCAD:

a. UH-60 Blackhawk

- Starter Tooling (4 items), \$12,821
- Anti-Ice Value Maintenance Kits (14 items), \$389,571
- Hydraulic Components and Automatic Hydraulic Pump Motor Test Stand (2 items), \$1,585,000
- Heater Blanket Control (176 items), \$144,478
- Hot Bonder System (85 items), \$24,840
- VSI/HSI Test Set Consoles (11 items), \$511,532
- Electrical Power Supplies (9 items), \$96,600
- Coordinated Measuring Machines (2 items), \$120,240
- Transmission Tooling Equipments (33 items), \$445,500
- Servo Assembly Tooling (6 items), \$27,621
- Automatic Ranging Leak Detector (3 items), \$33,650

- Digital ECU Test Stand (1 item), \$1,500,000
 - Engine Runout Test Stand (1 item), \$400,000
 - Woodward Governor (1 item), \$27,100
 - Line Test Set (1 item), \$31,440
 - Autoclave System (1 item), \$1,937,000
- b. OH-58D Kiowa Warrior
- VIDS Special Tools (6 items), \$59,835
- c. CH-47D Chinook
- Gisholt Balancing Set (1 item), \$23,515
 - Universal Electronics Test Stand (1 item), \$185,400
- d. UH-60 Blackhawk, CH-47D Chinook, and AH-64 Apache
- Hydraulic Test Stands (four LE600R General Purpose Hydraulic Test Stands; one Model CC1000 Central Computer System Control Unit), \$187,516,700

2.3 DMPE MANPRINT PROGRAM

As mentioned in Section 1, the overall intent of this analysis was to address MANPRINT considerations and concerns involving the procurement of DMPE material for CCAD. The DMPE MANPRINT Program was established to ensure that the staff at CCAD was sufficient in number (manpower), possessed the proper mix of Skills, Knowledge and Abilities (SKAs) (personnel), and are properly trained to accomplish tasks set forth as an organic depot facility for force modernization aircraft. Health Hazards, Safety, and Human Factors Engineering (HFE) were reviewed as well to ensure appropriate compliance.

For this analysis, some unique aspects of CCAD and DMPE arose in that very few of the maintenance and support staff at the depot are military personnel. Most of the manpower involved at CCAD is composed of Department of the Army (DA) civilians, primarily made up of wage grade personnel. As a result, a non-traditional MANPRINT approach of tabulating the MPT concerns was used to develop some of the costs associated with the DMPE program. Adherence to Occupational, Health and Safety Act (OHSA) guidelines was utilized to address health hazard, safety, and HFE considerations.

SECTION 3.0

TECHNICAL APPROACH

3.1 METHODOLOGY

AEPCO's methodology and technical approach involved detailed reviews of various DMPE program documentation which included DMPE reports and studies; DMPE program documentation; facility requirements; repair manuals; operations manuals; Integrated Logistics Support Plans (ILSPs); New Equipment Training Plans; Reliability, Availability and Maintainability (RAM) Rationale Reports; specific DMPE materiel requirements; program overview briefing materials; appropriate training publications; depot maintenance personnel job descriptions; and any other documentation recommended by CCAD and the Army Aviation and Troop Command (ATCOM) DMPE Section.

Total integration of all DMPE acquisition efforts was beyond the scope of this delivery order. However, separate DMPE procurement actions were reviewed, analyzed, and amended so that considerations for MANPRINT, particularly MPT, were included. The results of these separate DMPE acquisition reviews and their associated analyses were then all consolidated and used as reference data in the development of this Technical Report. **Figure 3-1** provides a process flow-type overview of the technical approach of this analysis.

With this basic understanding in place, there was a review of other current and appropriate DMPE systems to determine if the operator and maintainer tasks are applicable to this acquisition effort. This review was designed to identify the high driver and resource intensive tasks for eventual mitigation and abatement as well as the identification and clarification of costs regarding various options to support CCAD and ATCOM.

Once these reviews were completed and issues are known, the team will identify the specific analytical efforts required and their associated data requirements. Analysis priorities were then established based on the importance of the issue(s) that the analysis will answer. Prior to IPR-A, team representatives consulted with the Subject Matter Experts (SMEs) initially identified by the Government at the Delivery Order Initiation Meeting (DOIM). These consultations focused on confirming that the issues and risks identified were still applicable to DMPE acquisitions and have not been resolved by another means. SMEs were also queried about input data and data interpretation. These issues/information requirements, proposed analysis efforts/updates, and proposed analysis priorities were then presented to the Government at IPR-A.

Another issue of the analysis focused on potential workload impacts caused by employment of new DMPE materiel. Additional workload burdens on MOSs were measured to determine the impact on manpower and training requirements. A personal computer (PC) based software program was used by a knowledgeable Army force development/manpower

DMPE MANPRINT ANALYSES TECHNICAL APPROACH

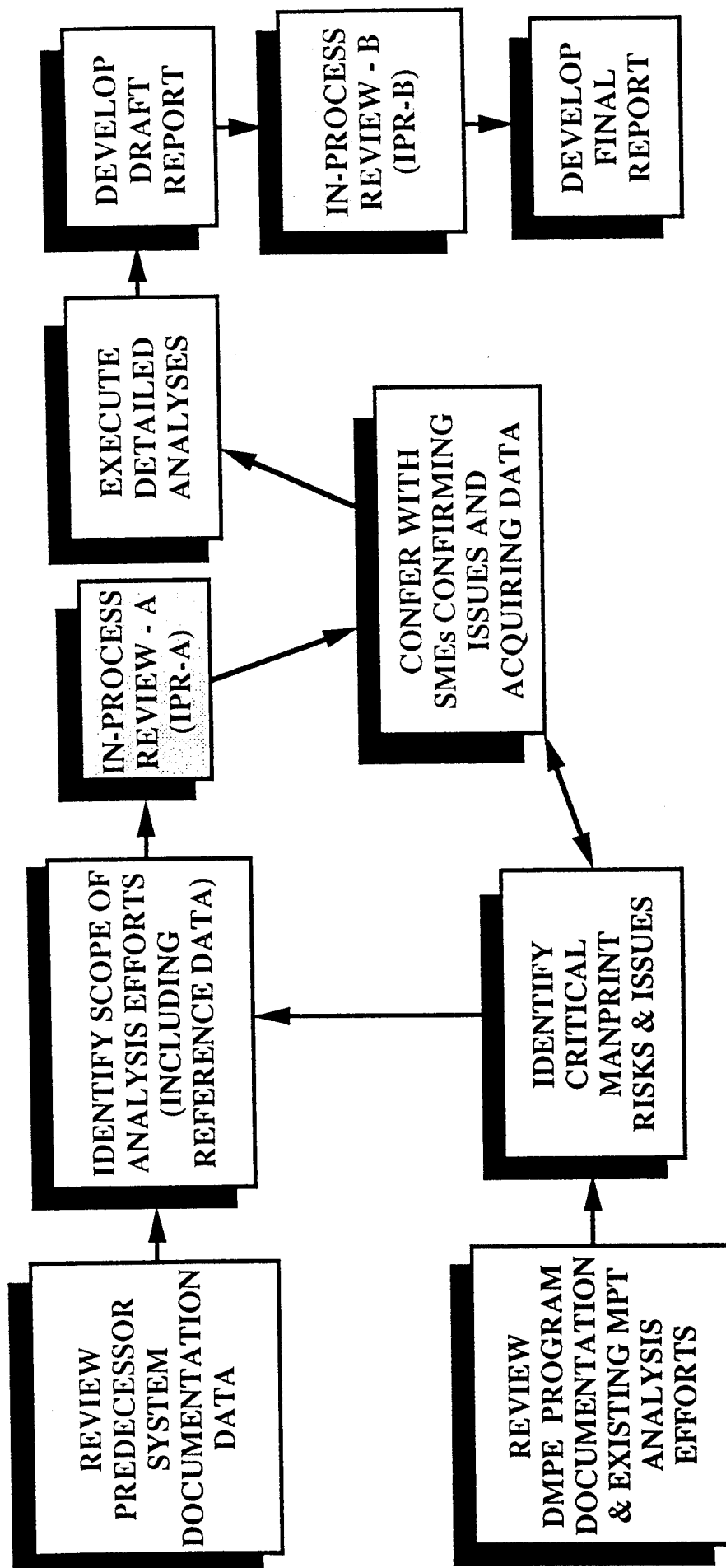


Figure 3 - 1

manpower analyst to determine manpower differences (deltas) caused by fielding the DMPE versus other systems. Requirements for any new combined operator/maintainer skills were also be reviewed. Solutions to reduce or simplify resource intensive tasks were also sought. These took the form of materiel labor saving aids or improved training methods. Any safety, health hazards, or man/machine problems associated with the DMPE were also reviewed by contractor experts from these respective MANPRINT disciplines.

Following these discussions, the team then proceeded with those analyses that are considered most important for the user in support of the development of the DMPE acquisition effort. These analysis results were reviewed and, then, with additional analytical effort, were refined and consolidated into this Technical Report which was presented at IPR-B.

Once the Government has provided feedback and comments, this report shall be revised and updated accordingly into the Final Technical Report (CDRL A007) which will in turn be delivered to the Government.

3.2 SYSTEM SPECIFIC CONCERNS

Areas of specific concern that ATCOM and CCAD sought to address dealt with maintenance functions, at the depot level, involving hydraulic systems for the force modernization aircraft. Electronic systems are also an area of prime concern, especially with all of the technological advancements which have occurred and their subsequent application to military aircraft. The government has had difficulty keeping pace with its maintenance capabilities to service these systems, hence there developed a strong reliance on Contractor Logistics Support (CLS) to overcome these shortcomings. As mentioned earlier in Section 1, it is the government's intention to reduce that dependence on CLS and develop its own organic depot capability.

3.3 SUBJECT MATTER EXPERTS (SMEs) AND GOVERNMENT FURNISHED INFORMATION (GFI)

The following is a list of SME personnel who provided valuable insight into specific issues regarding equipments procured by the government as a part of the DMPE Program:

<u>SME/POC</u>	<u>ORGANIZATION</u>
Sean Gorman	Allied Signal, Inc.
Sandy Hayward	Allied Signal, Inc.
Charlie Richardson	CCAD
Butch Vaughn	CCAD
Jerry Clark	Dayton T. Brown, Inc.

Jolin Herley	Dayton T. Brown, Inc.
Tommy Nuggent	CCAD
Eric Martin	CCAD
Elaine Medina	Kelley AFB (ALC)
Richard Ladd	Kelley AFB (ALC)
Hank Kuffman	NAS Pensacola
Elaine Lambert	CCAD
Rodney Mayo	CCAD
Dan Sarosky	Tobbyhanna Army Depot
Tom Swenson	CCAD
Butch Vaughn	CCAD
Charlie Richardson	CCAD
Jim Bordon	Sikorsky Aircraft
Mark Galleylen	Sikorsky Aircraft
John Sullivan	General Electric
Terry Taricco	Taricco, Inc.
Richard Nishnimuro	Taricco, Inc.
Sam Alvarez	CCAD
Larry Young	ATCOM/AEPCO

GFI was also used in the accomplishment of this analysis. Although large amounts of GFI were originally requested, the bulk of necessary reference data was obtained from the following:

- DMPE Program Plans
- Studies and Documentation
- U.S. Army Maintenance Data Management System
- U.S. Army Depot Automated Pilot Overhaul Program
- Digital Storage and Retrieval Engineering Data System
- U.S. Government Contract Data Requirements List
- National Stock Number Master Data Records
- Assorted Equipment Operation and Maintenance Materials

SECTION 4.0

ANALYSIS CONCERNS AND FINDINGS

4.1 REVIEW AND ANALYSIS OF GFI

Analysts first reviewed the different activities and resources associated with CLS for force modernization aircraft. These analyses were conducted in concert with representatives of ATCOM's DMPE Section and CCAD's business office. The overall government plan for DMPE and its objectives was reviewed as was the means by which those objectives were to be achieved. The Organic Depot Pilot Program was originally conceived in FY 92 as mentioned in Section 1. **Figure 4-1** provides an overview of the status of that program and its degree of success as of July 1994. It indicates the total number of components being serviced at the organic depot level maintenance at CCAD for each of the force modernization aircraft. **Figures 4-2, 4-3, 4-4, and 4-5** provide an overview of the percentage of depot level maintenance actions being accomplished by CCAD for the AH-64 Apache, OH-58D Kiowa Warrior, UH-60 Blackhawk, and CH-47D Chinook helicopters respectively.

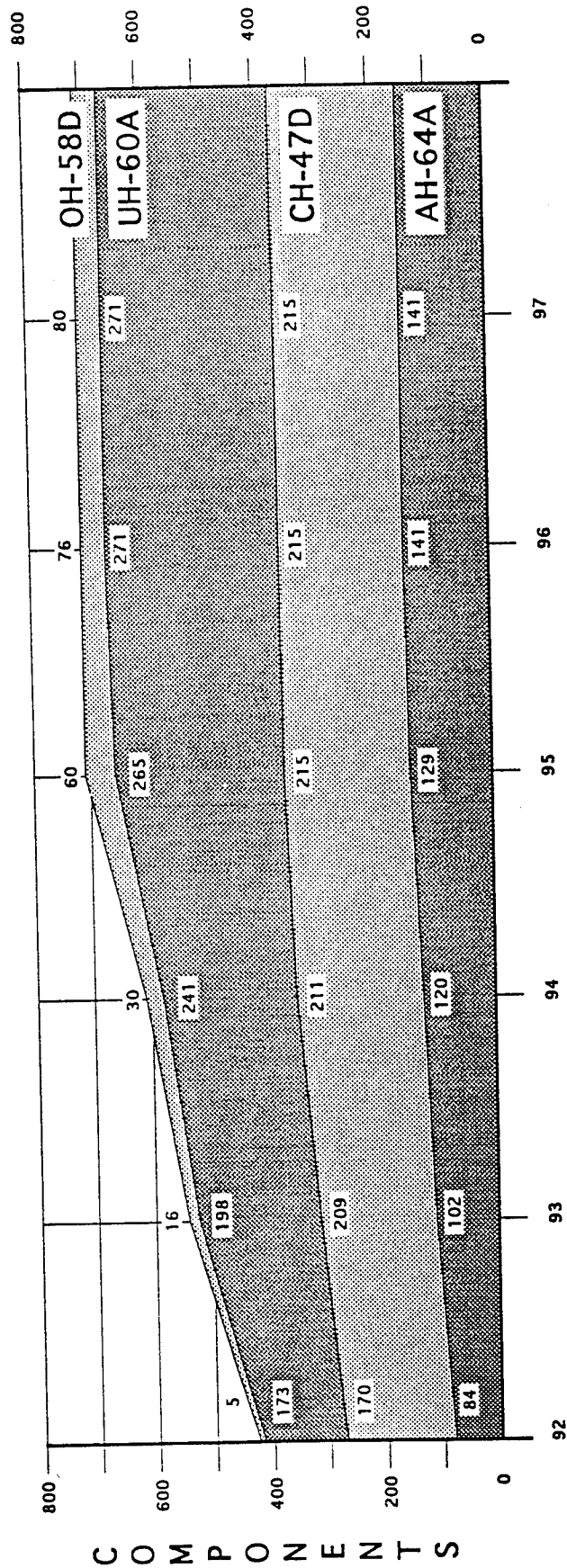
These increased in capability have corresponding increases in MPT requirements as well. Specific costs associated with the new requirements were determined through consultations with SMEs at CCAD's Business and Resource Management Offices in Corpus Christi, TX. These costs were then compared to CLS expenditures per aircraft for similar maintenance services. Because of the constantly evolving technologies involved in the DMPE program and the relative infancy of SKAs among government personnel, most of the cost figures associated with the new organic depot maintenance capability were based on Rough Orders of Magnitude (ROMs) obtained from CCAD and ATCOM representatives.

4.2 FINDINGS

As mentioned in Section 2.2, numerous systems were analyzed in the DMPE program. Not only were the costs of the associated hardware tabulated, but their respective impacts on the staffing at CCAD. More specifically, the effects on the number of people required (manpower) and the SKAs of those people (personnel). Since the bulk of the work force at CCAD is comprised of Department of the Army (DA) civilians, analyses of tasks and skills according to Military Occupational Specialty (MOS) were not possible. Basic cost computations were made though and compared to government expenditures for CLS for like services. Development of this in-house organic depot capability and transition away from CLS has lead to the following cost calculation process:

a. When Unit Funded Costs (UFCs) are on file for both organic and commercial programs for the year in question, these costs are multiplied by the quantity completed to determine program values for each. The resulting organic program value is subtracted from the commercial program value to determine savings.

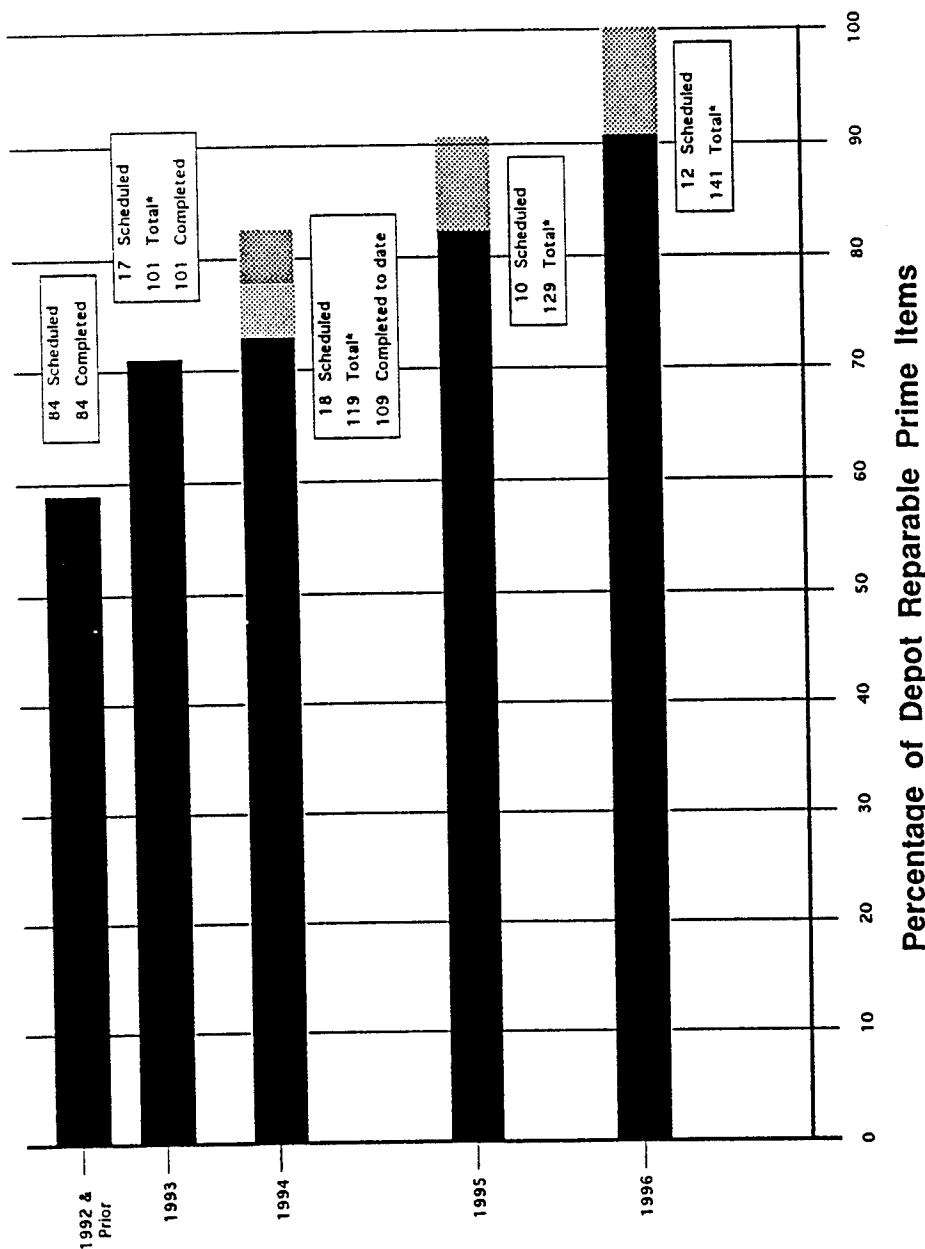
ORGANIC DEPOT PILOT PROGRAM STATUS



	FY92		FY93		FY94		FY95		FY96		FY97		TOTAL	
	Sched.	Comp.	Sched.	Comp.	Sched.	Comp.	Sched.	Comp.	Sched.	Comp.	Sched.	Comp.	Sched.	Comp.
AH-64A	84	84	18	18	18	8	9		12				141	110
CH-47D	170	170	39	39	2	2	4						215	211
UH-60A	173	173	25	25	43	36	24		6				271	234
OH-58D	5	5	11	11	14	13	30		16		4		80	29
FY-TOTAL	432	432	93	93	77	59	67	0	34	0	4	0	707	584

FIGURE 4 - 1

AH-64A TOTAL AIRCRAFT SYSTEM DEPOT TRANSITION STATUS **FY Pilot Organic Overhaul Schedule**



Key:

Actual or anticipated pilot overhaul completions

Pilot Overhauls completed during the current FY

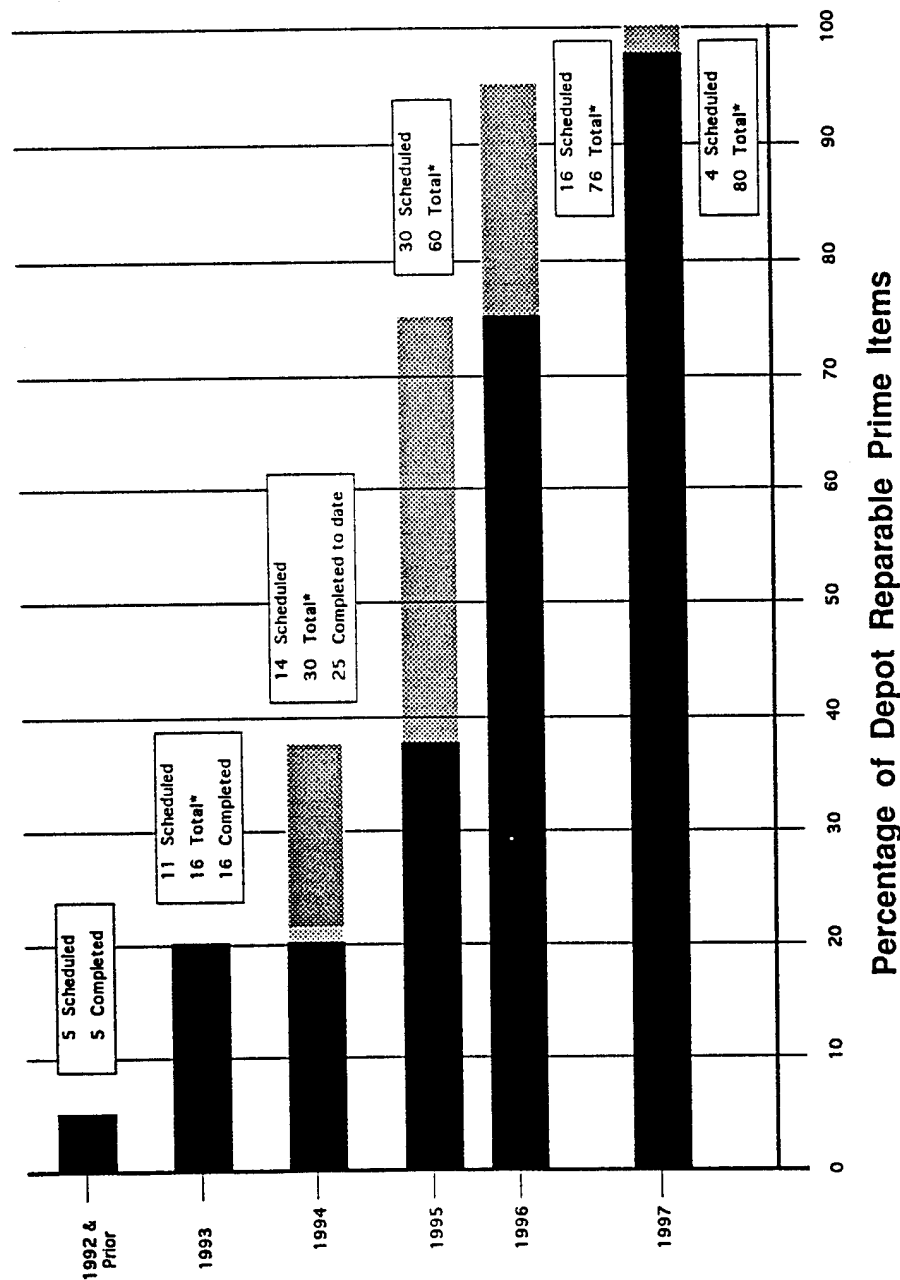
Items scheduled for pilot overhauls during the fiscal year

* Indicates that all totals are cumulative, i.e., they include quantities for the indicated year and all prior years.

Figure 4 - 2

OH-58D TOTAL AIRCRAFT SYSTEM DEPOT TRANSITION STATUS

FY Pilot Organic Overhaul Schedule



Key:

Actual or anticipated pilot overhaul completions

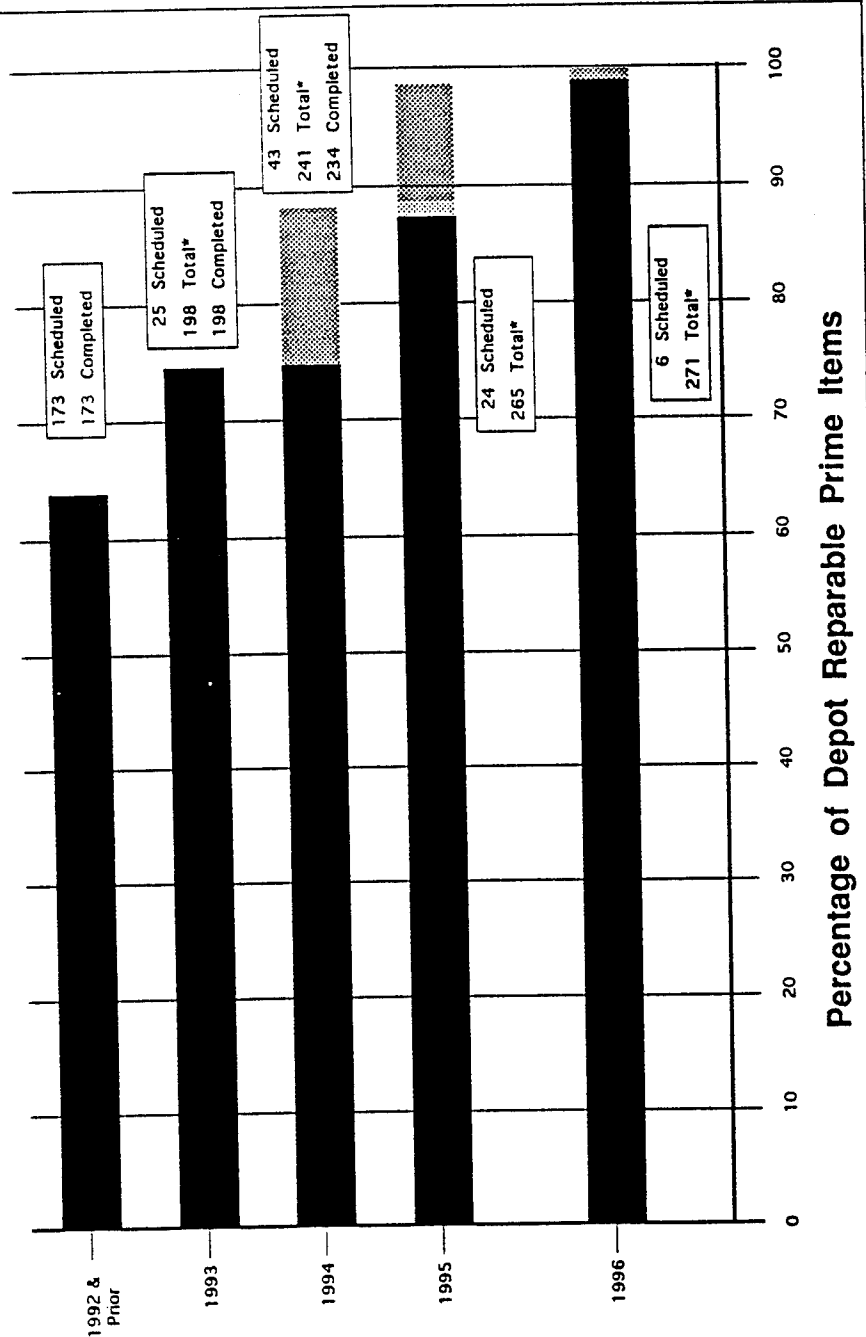
Pilot Overhauls completed during the current FY

Items scheduled for pilot overhauls during the fiscal year

* Indicates that all totals are cumulative, i.e., they include quantities for the indicated year and all prior years.

Figure 4 - 3

UH-60A TOTAL AIRCRAFT SYSTEM DEPOT TRANSITION STATUS FY Pilot Organic Overhaul Schedule



Key:



Actual or anticipated pilot overhaul completions



Pilot Overhauls completed during the current FY



Items scheduled for pilot overhauls during the fiscal year

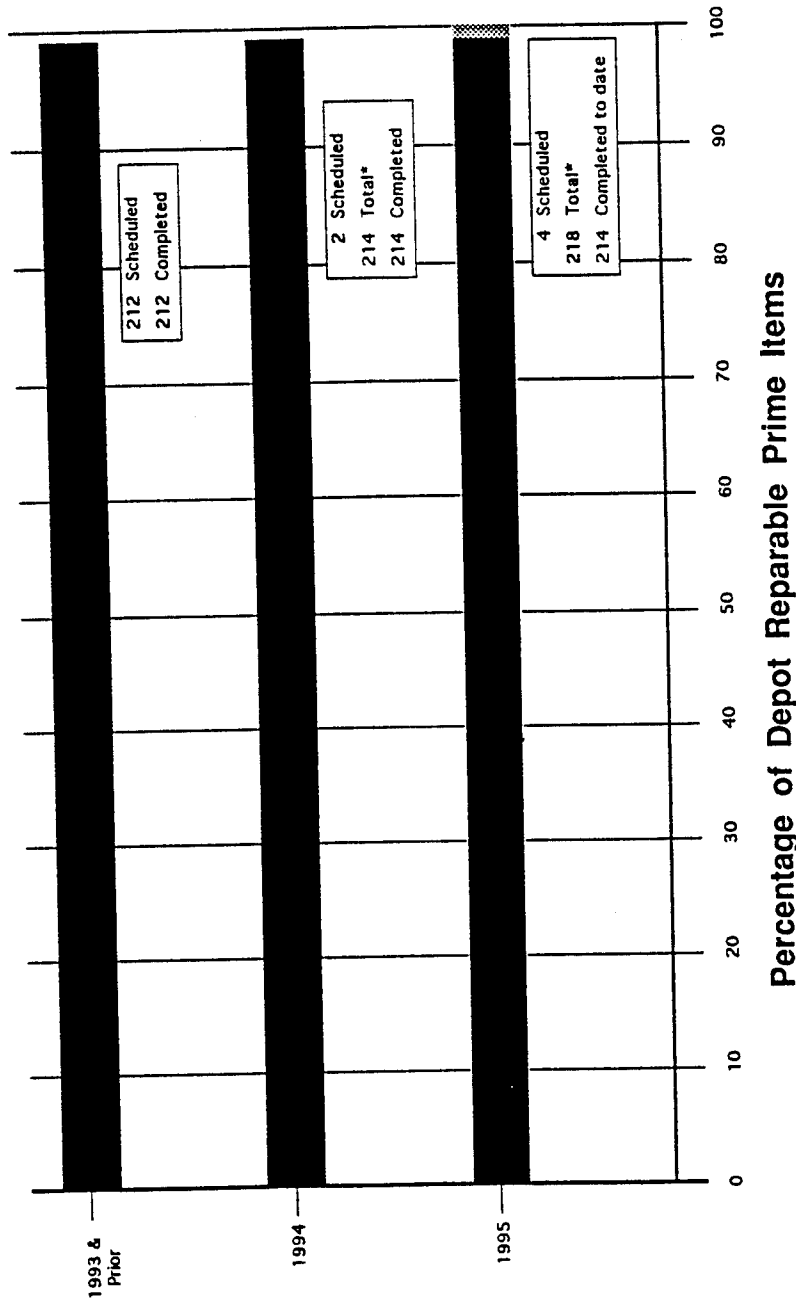
*

Indicates that all totals are cumulative, i.e., they include quantities for the indicated year and all prior years.

Figure 4 - 4

CH-47D TOTAL AIRCRAFT SYSTEM DEPOT TRANSITION STATUS

FY Pilot Organic Overhaul Schedule



- Key:**
- Actual or anticipated pilot overhaul completions
 - Pilot Overhauls completed during the current FY
 - Items scheduled for pilot overhauls during the fiscal year
- * Indicates that all totals are cumulative, i.e., they include quantities for the indicated year and all prior years.

Figure 4 - 5

b. If there is no commercial program in the same year as the organic program, the commercial unit funded cost from the prior year is used. The 1992 unit funded cost is divided by the 1992 hourly rate and multiplied by the 1993 rate to adjust for the difference, then savings are calculated as above.

c. If there is no commercial unit funded cost within a year of the organic program, but there is a figure available for organic man-hours, this number is multiplied by the difference between the commercial hourly rate and the organic hourly rate to determine savings.

d. If the unit funded cost and man-hours are not available, the savings are calculated by dividing the organic funded cost by the average organic hourly rate (\$115.49) to determine man-hours, then this figure is multiplied by the commercial hourly rate and the completed quantity to determine the commercial program value. The difference between this number and the organic program value is shown as savings.

e. Hourly rates used to compute savings:

- AH-64A commercial rate used: \$152.95
- CH-47D commercial rate used: \$229.28
- OH-58D commercial rate used: \$176.96
- UH-60 commercial rate used: \$151.66
- CCAD organic rate used: \$115.49

Figure 4-6 provides an overview of overall cost savings for each of the force modernization aircraft. Also, this figure breaks down these savings into overhaul efforts and repair programs. Overhaul calculations are relatively accurate in that they are set by the number of airframes and the amount of flight time generated. Repair program calculations are based on ROMs in that items tabulated in this category are repaired on an "as-needed" basis. Out year projected DMPE savings for FY 94, FY95, and FY 96 are provided in **Figure 4-7**.

4.3 RECOMMENDATIONS

There have been no increased requirements for manpower and personnel at CCAD. Any other additional costs (acquisition of the new DMPE hardware) have been greatly offset by much larger savings in CLS expenditures.

The U.S. Army Aviation's DMPE procurement program and its associated expanded capability of CCAD through the development of its organic depot maintenance program has proven to be an enormous benefit thus far. The government's ability to rely less on commercial sources for maintenance, coupled with the monetary savings, will continue to benefit the government well into the 21st century.

DMPE COST SAVINGS REPORT **(FY 93\$ AS OF APRIL 1994)**

<u>AIRCRAFT MODEL</u>	<u>OVERHAUL PROGRAMS</u>	<u>REPAIR PROGRAMS</u>	<u>TOTALS</u>
AH-64	\$476,976.32	\$1,283,834.00	\$1,760,810.32
CH-47D	\$14,441,875.11	\$2,053,219.93	\$16,495,095.04
OH-58D	\$5,148.11	\$1,670,829.59	\$1,675,977.70
UH-60	\$2,616,314.90	\$13,865,040.88	\$16,481,355.78
Totals	\$17,540,314.44	\$18,872,924.40	\$36,413,238.84

22 December 1988 DoD inflation rate provided by Army Materiel Command (AMC) to adjust this report to 1990 \$ is 1.0863.

Total Savings: \$36,386,235.00 * 1.0863 = \$39,555,701.35 (total savings adjusted to 1990 \$).

Figure 4 - 6

PROJECTED DMPE COST SAVINGS*

<u>AIRCRAFT MODEL</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>
AH-64	(174,671)	(177,400)	(97,872)
CH-47D	929,847	278,467	0
OH-58D	249,000	(13,463)	183,868
UH-60	(115,504)	185,049	11,613

* Note: Projected Savings calculated with 25% of 1st year program only & economy to scale not yet realized until the outyears.

Figure 4 - 7

The degree of success in the DMPE program thus far also indicates that other areas of Army maintenance may benefit as well through applying the same methodology. Analyses examining further expansion of CCAD's organic depot capability, as well as expanding the capabilities of intermediate maintenance organizations. Further studies should also be conducted into non-aviation areas where CLS is being procured. Effective and efficient use of in-house resources and capabilities will ensure "Best Value" from the Army.